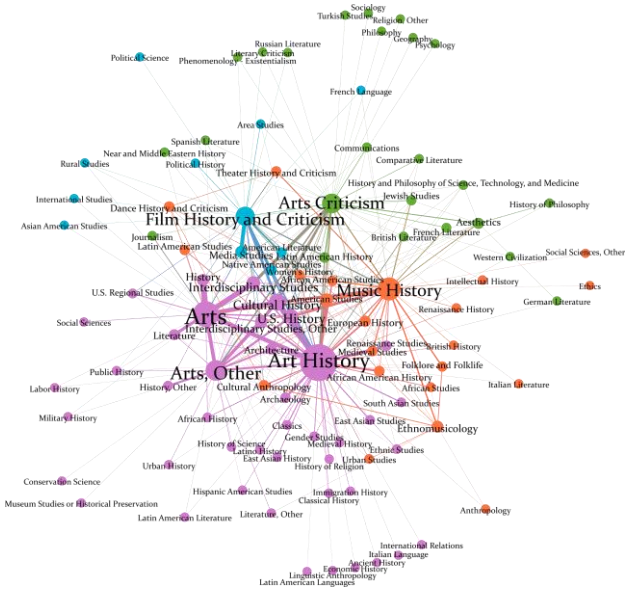
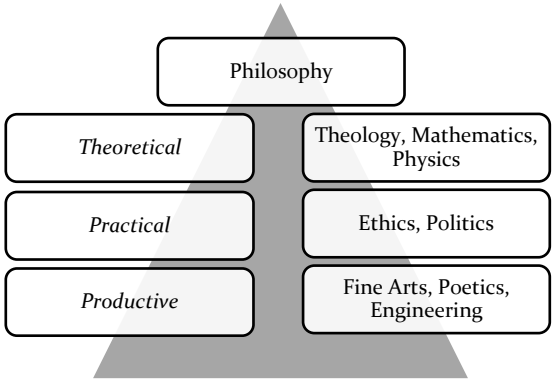
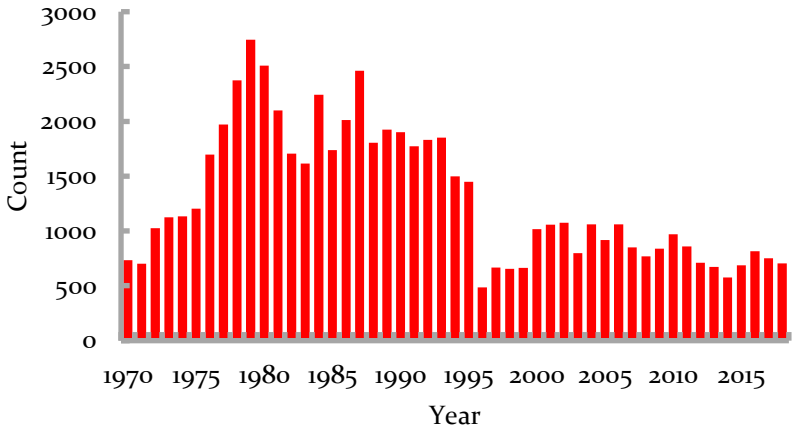
VPA 5300: The Digital Humanities in the Arts





Week 3 – 02
Tutorial: Inference



Outline

- Creating Data
- Methodological Distinctions
- Exploratory Data Analysis
  - Basic Visualizations
  - Descriptive Statistics
- Confirmatory Data Analysis
  - Hypothesis Testing
  - Correlational Designs
  - Experimental Designs

Research Pipeline

Digital Reception (Auto)Biographies

1) Select (shared) media platform.
2) Download/extract data from platform.
3) Explore data set.
4) Pose research question(s).
5) Scrape/query data OR annotate.
6) Analyze data.
7) Create presentation.

Research Pipeline

Digital Reception (Auto)Biographies

1) Select (shared) media platform.
2) Download/extract data from platform.
3) **Explore data set.**
4) Pose research question(s).
5) Scrape/query data OR annotate.
6) **Analyze data.**
7) Create presentation.

Creating Data

Decision Criteria

1. *Identifying Scope*
   - What are the boundaries of the phenomenon?
     - Time periods, countries, artists, artworks, genre
2. *Choosing Objects*
   - What objects will we represent and study?
     - Artworks, people, letters, scores
3. *Choosing Characteristics and Methods*
   - What characteristics of each object do we include?
     - Metadata (artist name), features (average brightness), properties, or attributes

Creating Data

(En)coding Data – Scales

- *Nominal* – a variable whose levels have no numerical, quantitative properties.

  Ex: College Major (Musicology, Art History)

- *Ordinal* – the levels can be rank ordered.

  Ex: Cadence Categories (PAC, IAC, HC)

- *Interval* – the intervals between levels are equal.

  Ex: Preference (1–7 scale)

- *Ratio* – equal intervals and an absolute 0.

  Ex: Years of training (0–10)

Methodological Distinctions

Qualitative vs. Quantitative Methods

Qualitative Methods

- Evidence that cannot be easily quantified.
  - Participant-Observation
  - Interview
  - Textual Analysis

Quantitative Methods

- Evidence that can be expressed numerically.
  - Experiments
  - Surveys
  - Computational Modeling

Methodological Distinctions

Exploratory vs. Confirmatory Analysis

Exploratory Analysis

- Exploring (i.e., visualizing) data to generate research questions and/or hypotheses.
- Methods:
  - descriptive statistics
  - dimensionality reduction (i.e., data visualization)

Confirmatory Analysis

- Examining a specific research question and/or hypothesis using methods of statistical inference (i.e., falsification, replication)
- Methods:
  - inferential statistics (i.e., hypothesis testing)
  - correlational and experimental designs

Exploratory Data Analysis

Methods

Data visualization

- identify the relationships between objects.
- plots, charts, networks, tree diagrams, etc.
- Often requires algorithms to encode the data, extract features, and reduce complexity.

Common algorithms

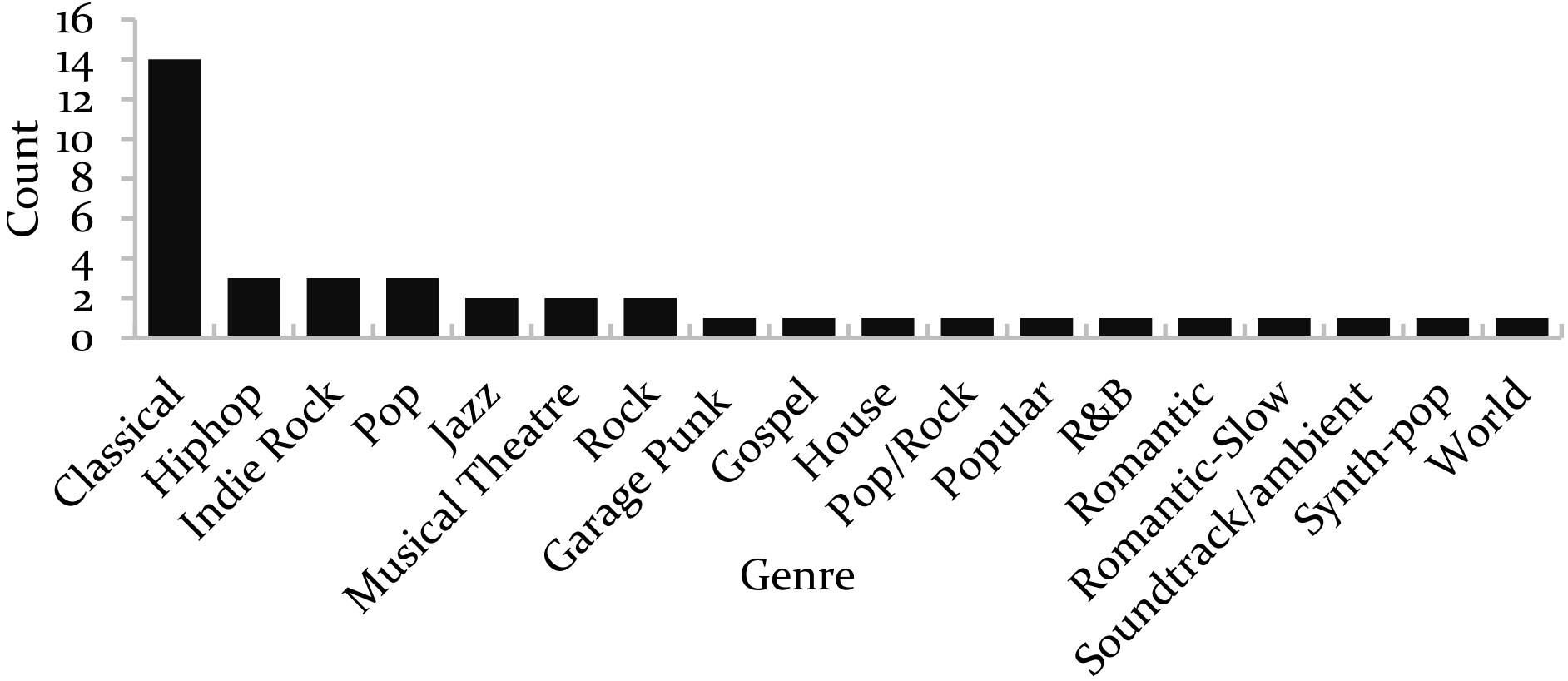
- Descriptive statistics
- Dimensionality reduction
  - multidimensional scaling (MDS), principal components analysis (PCA), factor analysis

Basic Visualizations

(Frequency) Distributions – Bar

- List your preferred music genre (free response).
- 40 participants.

– Sears et al. (2018)

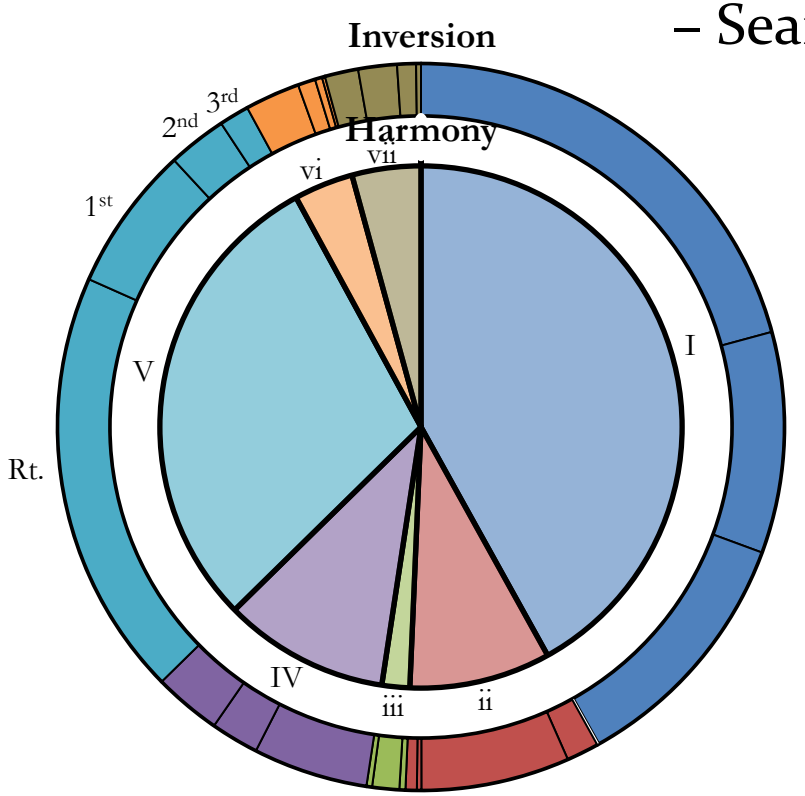


Basic Visualizations

(Frequency) Distributions – Pie

- Percentage of diatonic chord types in the Haydn corpus.

– Sears (in press)

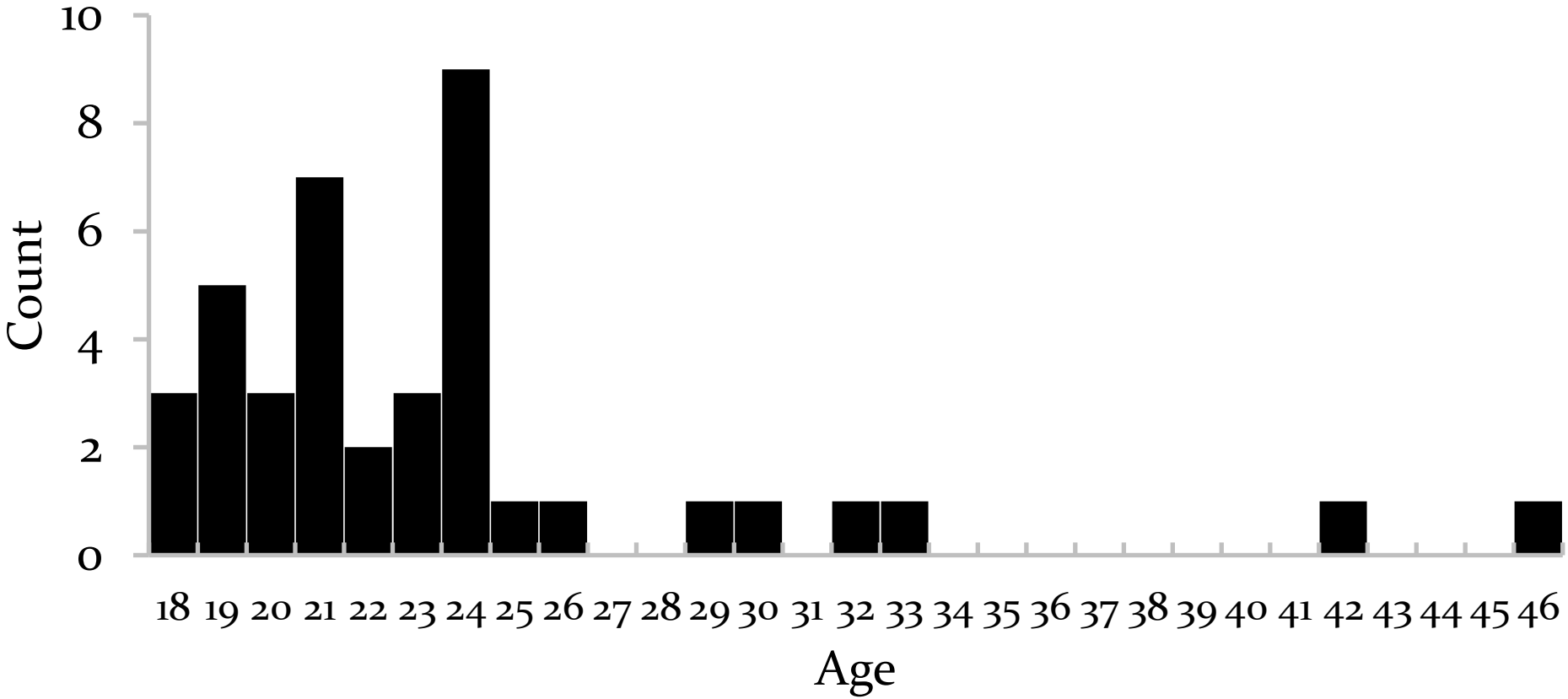


Basic Visualizations

(Frequency) Distributions – Bar

- Age.
- 40 participants.

– Sears et al. (2018)

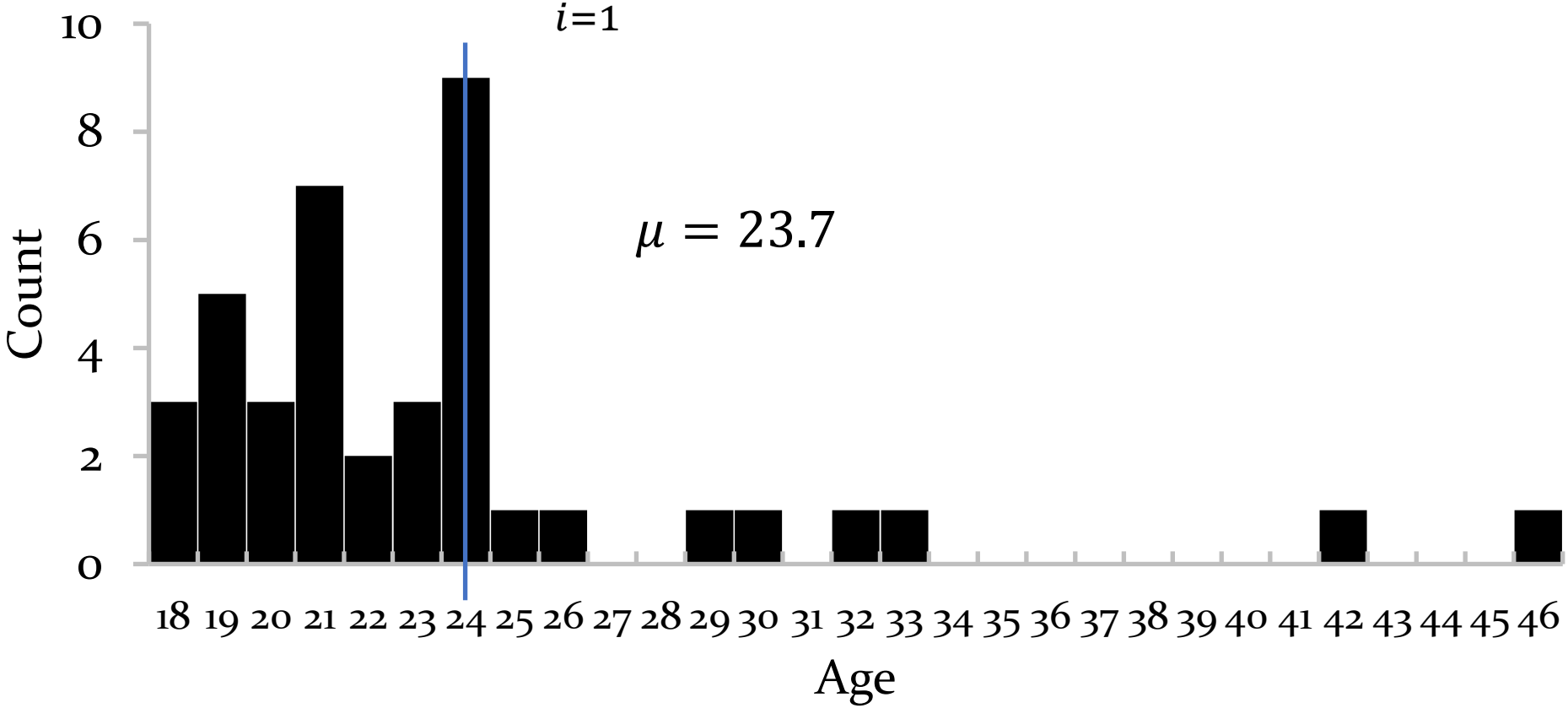


Descriptive Statistics

Central Tendency

- *Mean*

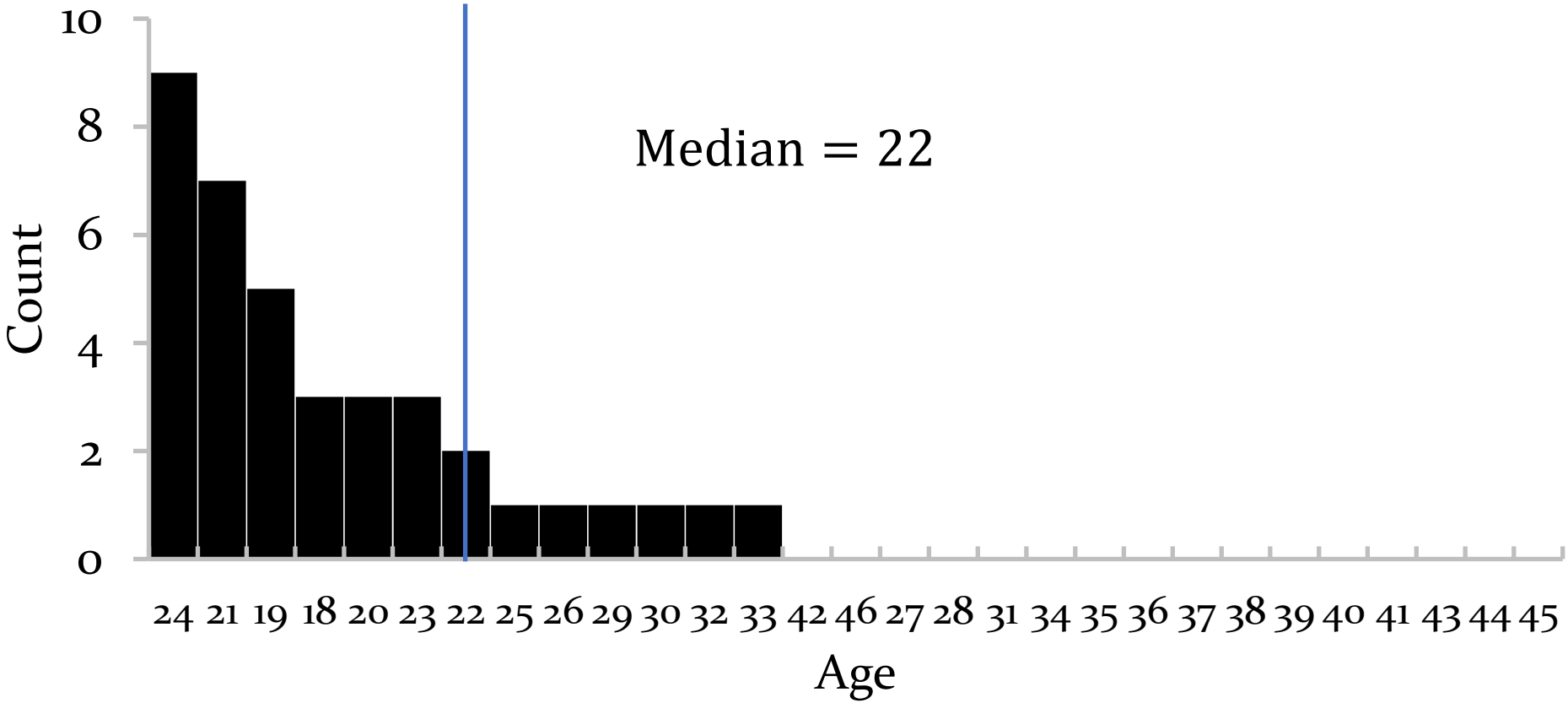
$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{x_1 + x_2 + \cdots + x_n}{n}$$



Descriptive Statistics

Central Tendency

- *Median* – the center value of the distribution



Descriptive Statistics

Central Tendency

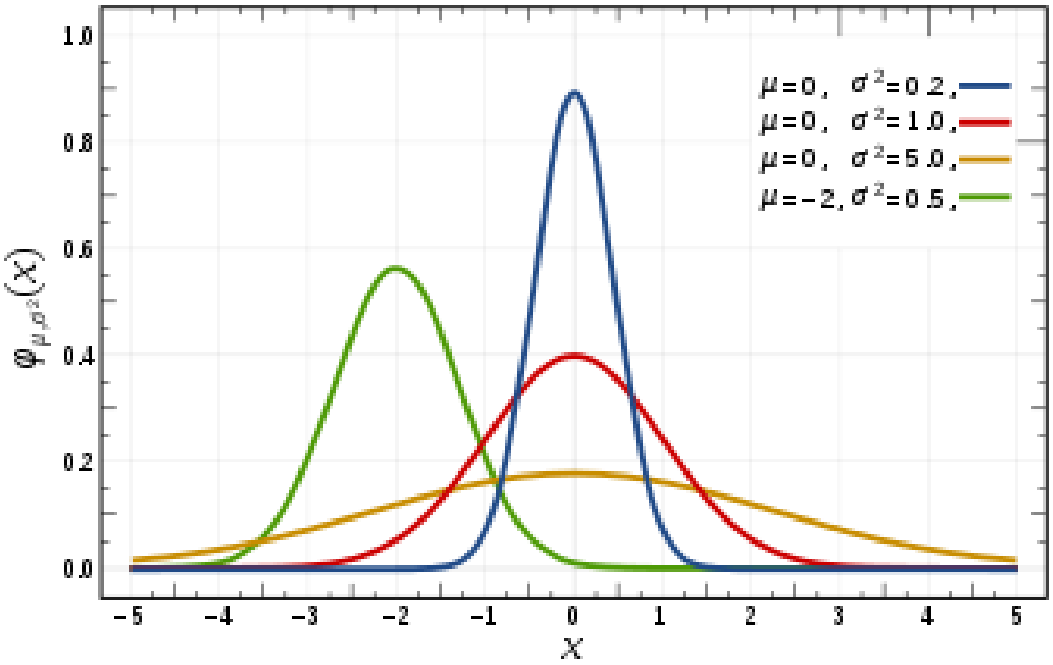
- *Mode* – the most frequent value in the distribution.

Descriptive Statistics

Variability

- *Variance* – measures the spread of the distribution.

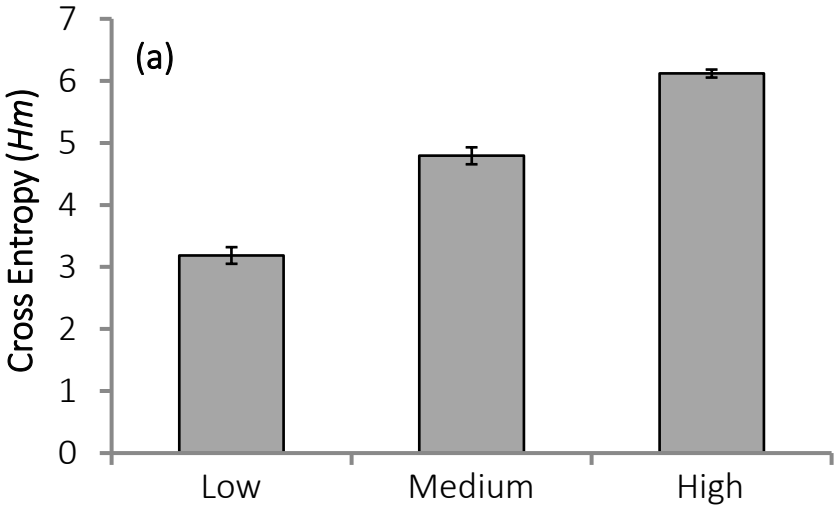
$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \mu_i)^2$$

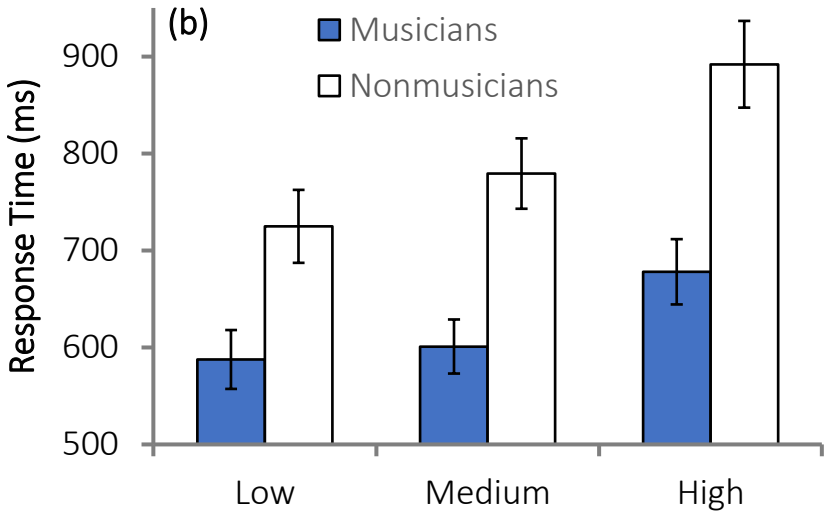


Basic Visualizations

Descriptive Statistics

– Sears, Verbeten, & Percival (in prep.)





Confirmatory Data Analysis

- Examining *a priori* research questions using methods of statistical inference (hypothesis testing).
- The null hypothesis is never proved or established, but is possibly disproved.

H_0	The null hypothesis; there is no difference between two measured phenomena.
H_1	There is a difference between two measured phenomena.

Confirmatory Data Analysis

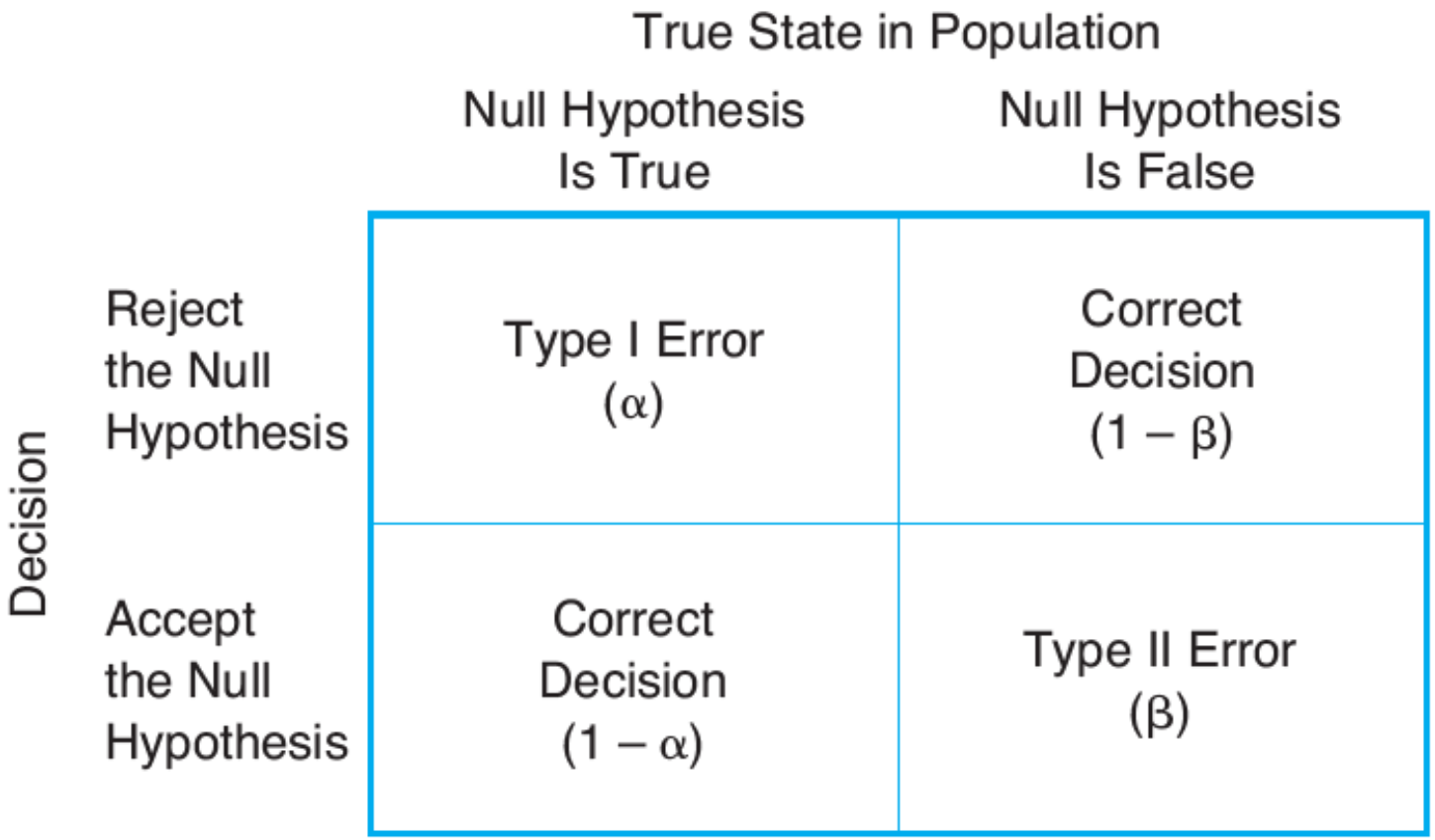
- Examining *a priori* research questions using methods of statistical inference (hypothesis testing).
- The null hypothesis is never proved or established, but is possibly disproved.

H_0 Music training has no effect on pitch discrimination.

H_1 Music training improves pitch discrimination.

Confirmatory Data Analysis

Errors of Inference



Hypothesis Testing

- "Lady Tasting Tea" experiment – Fisher (1935)

H_0 Muriel Bristol cannot tell whether the tea or the milk was added first to the cup.

H_1 Muriel Bristol can tell whether the tea or the milk was added first to the cup.

Hypothesis Testing

- "Lady Tasting Tea" experiment – Fisher (1935)

H_0 Muriel Bristol cannot tell whether the tea or the milk was added first to the cup.

H_1 Muriel Bristol can tell whether the tea or the milk was added first to the cup.

Hypothesis Testing

- "Lady Tasting Tea" experiment – Fisher (1935)

H_0 Muriel Bristol cannot tell whether the tea or the milk was added first to the cup.

H_1 Muriel Bristol can tell whether the tea or the milk was added first to the cup.

$$\frac{8!}{4!\,(8-4)!} = 70 \text{ possible combinations}$$

Hypothesis Testing

- "Lady Tasting Tea" experiment – Fisher (1935)

H_0 Muriel Bristol cannot tell whether the tea or the milk was added first to the cup.

H_1 Ms. Bristol can tell whether the tea or the milk was added first to the cup.

$$\frac{1}{70} = .014$$

Hypothesis Testing

- "Lady Tasting Tea" experiment – Fisher (1935)

H_0 Muriel Bristol cannot tell whether the tea or the milk was added first to the cup.

H_1 Ms. Bristol can tell whether the tea or the milk was added first to the cup.

1.4%

$p = .014$

Study Designs

Correlational Studies

- Task: Measure associations among variables.
- Purpose: prediction.
- Limitation: Causality & 3rd variable problem.

Experimental Studies

- Task: Determine how manipulating one variable (Independent) affects another (dependent).
- Purpose: Causality and prediction.

Correlational Designs

Statistics

- *Correlation*: Measures the strength of the relationship between two variables (*r*: –1.0 to 1.0).
- *Regression*: measures whether changes in one variable predict changes in another (R^2: 0 to 1).

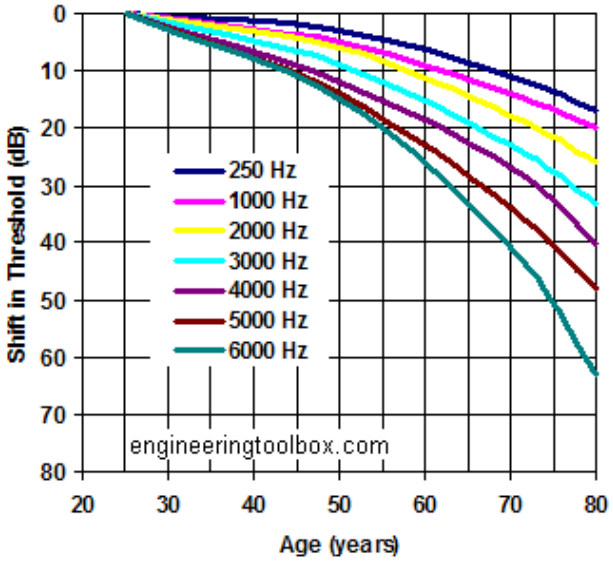
H_0 Age does not affect hearing loss.

H_1 Age affects hearing loss.

Correlational Designs

Statistics

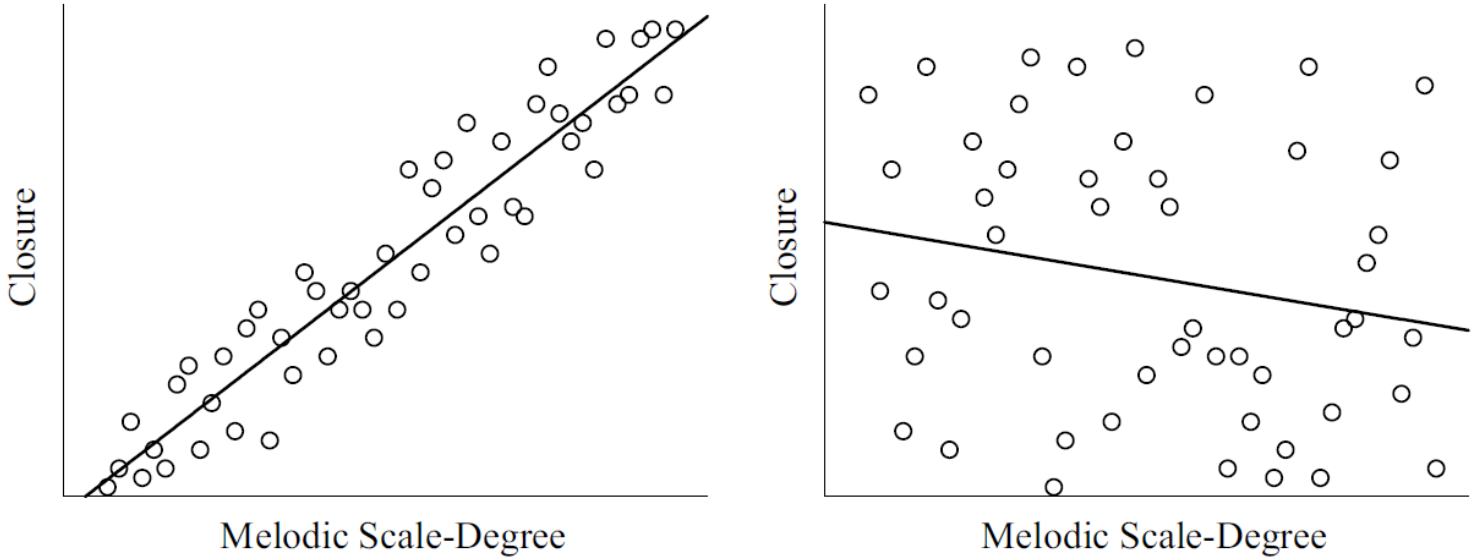
- *Correlation*: Measures the strength of the relationship between two variables (*r*: –1.0 to 1.0).
- *Regression*: measures whether changes in one variable predict changes in another (R^2: 0 to 1).



Correlational Designs

Pearson's r

- *Correlation*: Measures the strength of the relationship between two variables (*r*: –1.0 to 1.0).
- *Regression*: measures whether changes in one variable predict changes in another (R^2: 0 to 1).



Correlational Designs

3rd variable problem / Causality

- Confounding variables

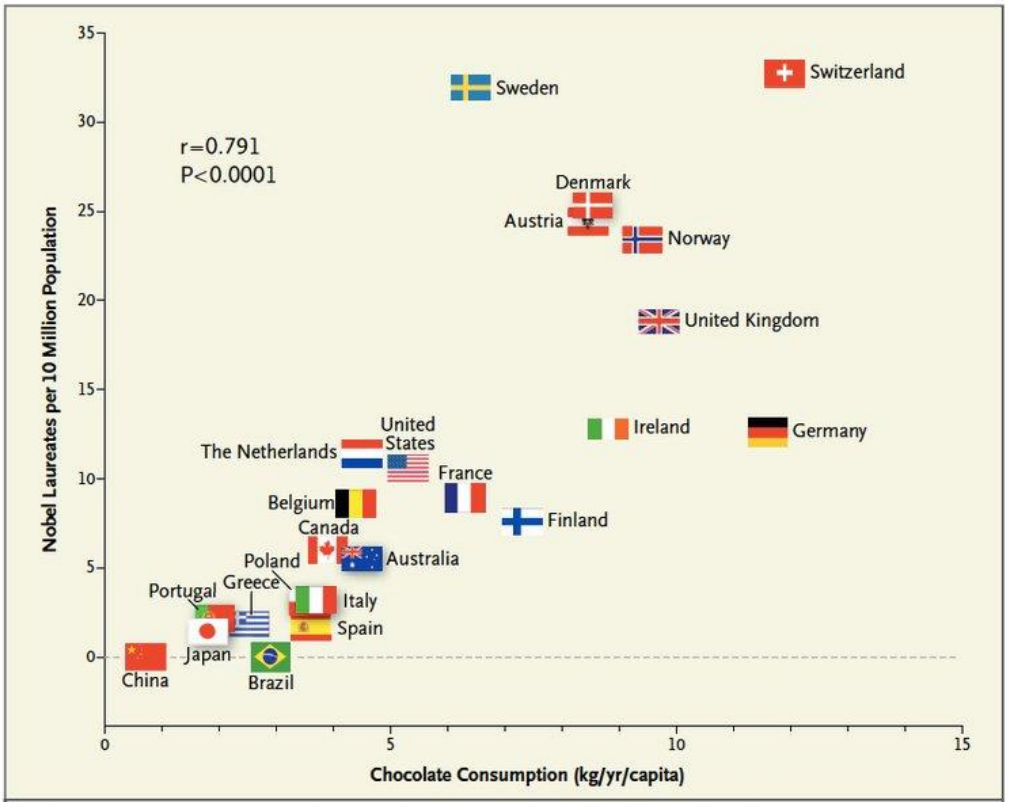


Figure 1. Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.

Study Designs

Correlational Studies

- Task: Measure associations among variables.
- Purpose: prediction.
- Limitation: Causality & 3rd variable problem.

Experimental Studies

- Task: Determine how manipulating one variable (Independent) affects another (dependent).
- Purpose: Causality and prediction.

Experimental Designs

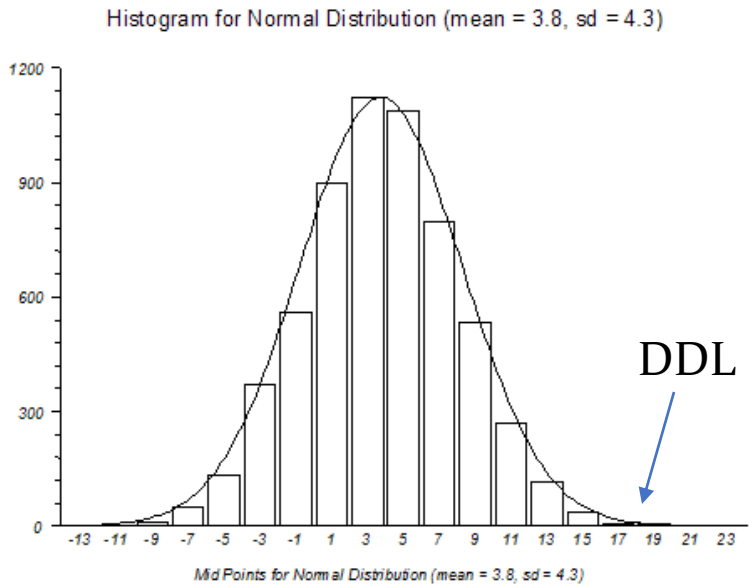
- Example: Acting Proficiency (case)
  - Create control group (*N*=100). Measure acting proficiency on an interval/ratio scale (e.g., -30 to 30).
  - Variable-match the controls with our case participant (age, vocation, years of training, etc.).

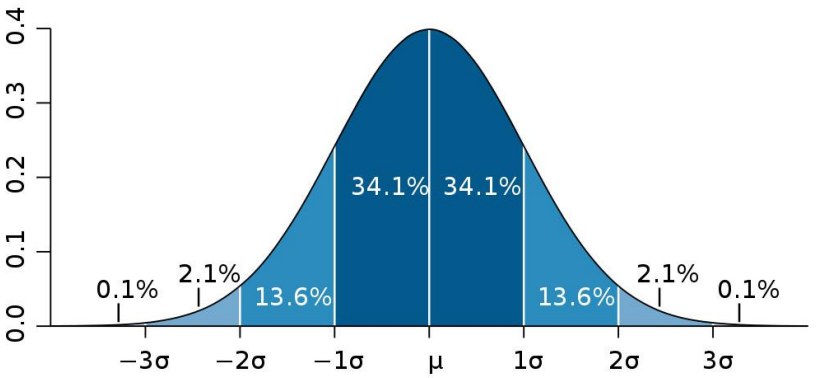
H_0 Daniel Day Lewis is an average actor.

H_1 Daniel Day Lewis is a better-than-average actor.

Experimental Designs

- Example: Acting Proficiency (case)
  - Create control group (*N*=100). Measure acting proficiency on an interval/ratio scale (e.g., -30 to 30).
  - Variable-match the controls with our case participant (age, vocation, years of training, etc.).

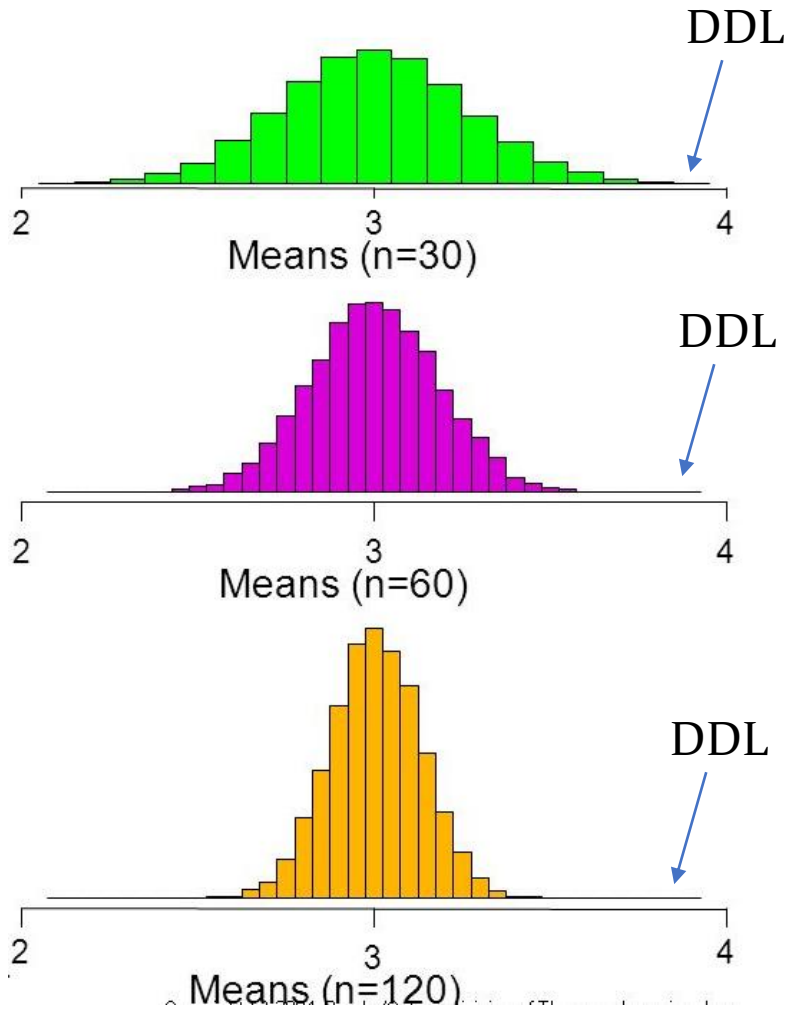




Experimental Designs

- Sample Size / Effect Size

- As *N* increases, σ decreases.
- As *N* increases, the *p*-value for H_o decreases.
- Effect size measures the size of the difference.



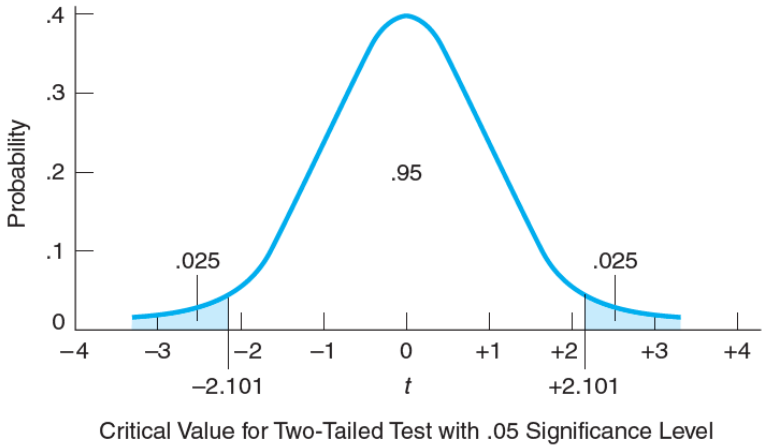
Experimental Designs

- Example: Acting Proficiency (2 Groups)
  - Create two groups (*trained, untrained*). Measure acting proficiency on an interval/ratio scale (e.g., -30 to 30).
  - Variable-match the controls with our case participant (age, vocation, years of training, etc.).

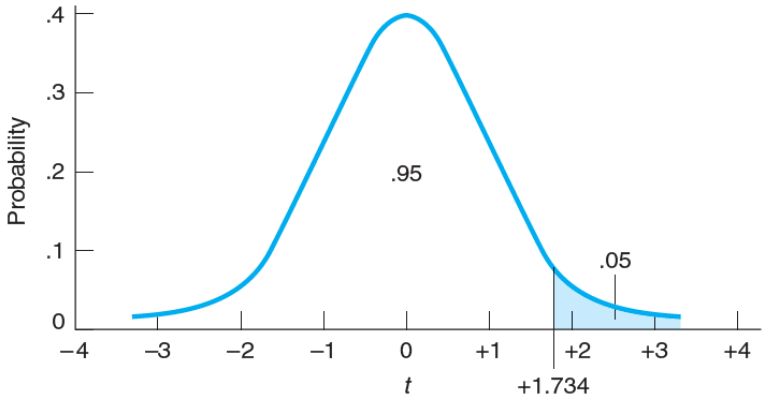
H_0 Training does not increase acting proficiency.

H_1 Training increases acting proficiency.

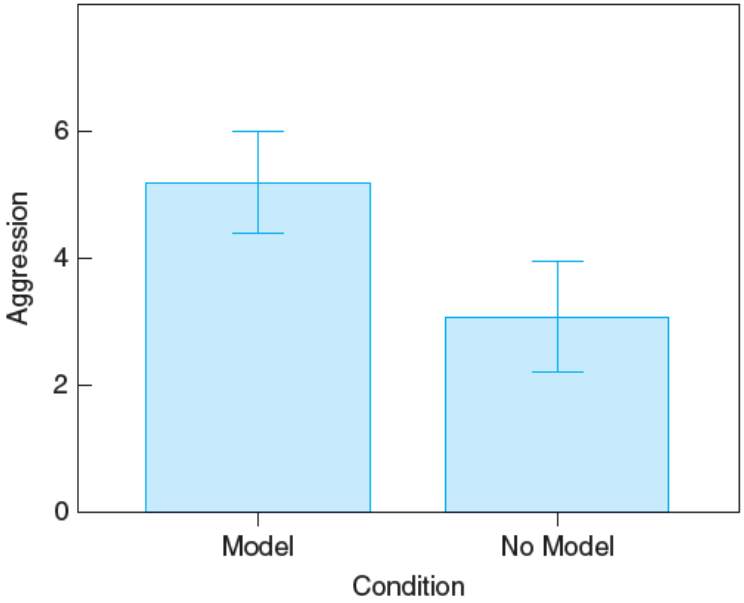
Experimental Designs



Critical Value for Two-Tailed Test with .05 Significance Level



Critical Value for One-Tailed Test with .05 Significance Level



Next Class (Tuesday, 9/14)

- Representation

Homework:

- READING: Hoover, “Arguments, Evidence…” (20 pages)